

DESCRIPTION

Title of Invention

RUDDER FOR SHIPS, STEERING METHOD, AND SHIP

5 Technical Field

[0001]

The present invention relates to a rudder for ships,
a steering method, and a ship for effectively recovering a
propeller vortex flow.

10

Background Art

[0002]

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A rudder for ships is required to shorten a cord
length of the rudder in order to facilitate disposition of
a stern and reduce enlargement of the stern.

For example, means for satisfying the requirement
and maintaining steering performance is described in PTLs 1
and 2.

[0003]

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In a "two-rudder system for large ships" of PTL 1, a
pair of high lift rudders is disposed behind one propulsion
propeller. Each high lift rudder has a top end plate and a
bottom end plate at a top end portion and a bottom end
portion of a rudder blade, respectively. In addition, in
25 this system, a fin having a predetermined chord length is
provided rearward from a front edge portion at
substantially the same level as the axial center of the

propulsion propeller on an inner board surface of each rudder blade. In addition, in this system, a chord length of each rudder blade is 60 to 45% of a diameter of the propulsion propeller.

5 [0004]

In a "rudder for ships" of PTL 2, in a horizontal sectional shape of a rudder body, a shape of a front end portion is an arc shape or a shape similar to the arc shape, a width of a cross section gradually increases toward the rear of the rudder body to reach the maximum width, and the width of the cross section decreases while the cross section is changed from an outwardly convex shape to an outwardly concave shape. Thereafter, the horizontal sectional shape has a straight portion formed in a substantially parallel straight line to a rear end and has a rear end having a finite width.

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Citation List

Patent Literature

20 [0005]

PTL 1: Japanese Patent Publication Laid-open No. 2003-26096

PTL 2: Japanese Patent Publication Laid-open No. 2007-186204

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Summary of Invention

Technical Problem

[0006]

PTL 1 is known as a uniaxial two-rudder system. In the uniaxial two-rudder system, two rudders are disposed symmetrically behind the propeller. The uniaxial two-rudder system has a wide variety of maneuvering modes and excellent maneuverability. However, the rudder is disposed except for the propeller center, and an energy recovery rate of a propeller vortex flow deteriorates. Therefore, in the uniaxial two-rudder system, a fin is added or a cord length of the rudder is shortened to compensate for deterioration in the energy recovery rate of the propeller vortex flow. Accordingly, in general, it is necessary to extend the hull to reduce enlargement of a stern.

[0007]

Meanwhile, as described in PTL 2, a technique relating to the high lift rudder which increases lifting of the rudder itself has been studied. In the high lift rudder, it is possible to decrease a rudder area and increase an aspect ratio, and it is possible to shorten the cord length of the rudder. In general, a rudder of a latest ship has high lift, and thus, the cord length of the rudder is shortened to the limit. Therefore, even if the existing uniaxial two-rudder system is applied for further improvement of performance, the cord length of one rudder which becomes a base is shortened already, and thus, there is a problem that it is difficult to obtain the effects.

[0008]

The present invention is provided in order to further improve performance of a rudder of a latest ship. That is, an object of the present invention is to provide a rudder for ships, a steering method, and a ship capable of
5 effectively using energy of a propeller vortex flow and further decreasing an area of a rudder and a blade thickness.

Solution to Problem

10 [0009]

According to an aspect of the present invention, there is provided a rudder for ships, including: an upper rudder and a lower rudder which are vertically disposed behind and on an axis of a propeller disposed at a stern,
15 in which the upper rudder and the lower rudder are able to be independently turned to a port side and a starboard side from the axis of the propeller.

[0010]

The rudder for ships includes an upper steering
20 machine and a lower steering machine which are able to independently turn the upper rudder and the lower rudder.

[0011]

A thickness distribution of the lower rudder is thinner than that of the upper rudder.

25 [0012]

In a case where a rotation direction of the propeller is the clockwise direction when viewed from a

rear side, the upper rudder has an airfoil shape suitable
for a propeller vortex flow flowing from the port side to
the starboard side, and the lower rudder has an airfoil
shape suitable for a propeller vortex flow flowing from the
5 starboard side to the port side.

[0013]

The upper rudder and the lower rudder have the
airfoil shapes or camber lines of the airfoil shapes
different from each other.

10 [0014]

In addition, according to another aspect of the
present invention, there is provided a steering method,
including: preparing an upper rudder and a lower rudder
which are vertically disposed behind and on an axis of a
15 propeller disposed at a stern; and independently turning
the upper rudder and the lower rudder to a port side and a
starboard side from the axis of the propeller.

[0015]

During deceleration or deceleration turning, one of
20 the upper rudder and the lower rudder is turned to the port
side, and the other thereof is turned to the starboard side.

[0016]

Moreover, according to still another aspect of the
present invention, there is provided a ship including the
25 above-described rudder for ships.

Advantageous Effects of Invention

[0017]

According to the present invention, the upper rudder and the lower rudder are disposed at the propeller center (behind and on the axis of the propeller), and thus, it is possible to effectively recover energy of the propeller vortex flow by the upper rudder and the lower rudder.

[0018]

Particularly, when a ship goes straight ahead or turns, in the rudder for ships of the present invention, the upper rudder and the lower rudder are independently turned to obtain appropriate steering angles, and thus, it is possible to always realize a steering angle suitable for recovery of energy of the propeller vortex flow at any rotational speed of the propeller. As a result, compared to one rudder in which the upper rudder and the lower rudder are integrated with each other, in the rudder for ships of the present invention, it is possible to generate high lift and decrease a total rudder area.

[0019]

Compared to the one rudder in which the upper rudder and the lower rudder are integrated with each other, a rudder area of the upper rudder and the lower rudder is approximately halved, and thus, a design load of the upper rudder and the lower rudder decreases. Accordingly, a blade thickness decreases, and it is possible to improve rudder single body performance.

[0020]

Therefore, according to the present invention, it is possible to effectively use the energy of the propeller vortex flow and decrease the area and the blade thickness of the rudder.

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Brief Description of Drawings

[0021]

Fig. 1 is a side view illustrating an embodiment of a rudder for ships of the present invention.

10 Fig. 2 is a sectional view taken along line A-A of Fig. 1.

Fig. 3A is a schematic plan view of Fig. 1.

Fig. 3B is an explanatory view of a fluid force generated in an upper rudder when a ship goes straight ahead.
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Fig. 3C is an explanatory view of a fluid force generated in a lower rudder when a ship goes straight ahead.

Fig. 4A is a view illustrating positions of the upper rudder and the lower rudder when a ship goes straight ahead.
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Fig. 4B is a view illustrating positions of the upper rudder and the lower rudder when a ship turns left.

Fig. 4C is another view illustrating positions of the upper rudder and the lower rudder when a ship turns left.
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Fig. 5A is a view illustrating a deceleration mode of 90°.

Fig. 5B is a view illustrating a deceleration mode of 30°.

Fig. 6A is a view illustrating a deceleration right turning mode.

5 Fig. 6B is a view illustrating a deceleration left turning mode.

Description of Embodiments

[0022]

10 An embodiment of the present invention will be described with reference to the drawings. In addition, the same reference numerals are assigned to the common portions in each drawing, and overlapping descriptions thereof are omitted.

15 [0023]

Fig. 1 is a side view illustrating an embodiment of a rudder 100 for ships of the present invention, and Fig. 2 is a sectional view taken along line A-A of Fig. 1.

20 In Figs. 1 and 2, a reference numeral 1 indicates a ship, a reference numeral 2 indicates a stern, a reference numeral 3 indicates a baseline, a reference numeral 4 indicates a propeller center, a reference numeral 5 indicates a turning axis, a reference numeral 6 indicates a starboard side, and a reference numeral 7 indicates a port side.

25

[0024]

In this example, the baseline 3 is a horizontal line

corresponding to a lower surface of the ship 1. In addition, the propeller center 4 means an axis of a propeller 8. The propeller center 4 may be horizontal or may be inclined.

5 In this example, the turning axis 5 is a vertical axis and intersects the propeller center 4. In addition, the turning axis 5 may not be vertical to the propeller center 4 as long as the turning axis 5 intersects the propeller center 4.

10 In this example, a single propeller 8 is provided. However, the propeller 8 may be a counter-rotating propeller in which two propellers 8 rotate in directions opposite to each other.

[0025]

15 In Figs. 1 and 2, the rudder 100 for ships of the present invention includes an upper rudder 10A, a lower rudder 10B, an upper steering machine 20A, and a lower steering machine 20B.

[0026]

20 The upper rudder 10A and the lower rudder 10B are vertically disposed behind and on the axis of the propeller 8 disposed at the stern 2. The "rudder being disposed behind and on the axis of the propeller 8" means that the common turning axis 5 of the upper rudder 10A and the lower
25 rudder 10B is positioned on a vertical plane including the propeller center 4 behind the propeller 8.

[0027]

In Fig. 1, the upper rudder 10A and the lower rudder 10B are configured such that cord lengths L thereof are approximately the same as each other and rudder heights H thereof are approximately the same as each other. In addition, in this example, a boundary surface between the upper rudder 10A and the lower rudder 10B approximately coincides with a height of the propeller center 4.

Moreover, it is preferable that a lower end of the lower rudder 10B is positioned above the baseline 3.

[0028]

In addition, the present invention is not limited to this example. That is, the cord lengths L of the upper rudder 10A and the lower rudder 10B may be different from each other or the rudder heights H thereof may be different from each other. Moreover, the position of the boundary surface between the upper rudder 10A and the lower rudder 10B may be different from the position of the propeller center 4.

[0029]

In Figs. 1 and 2, the upper rudder 10A and the lower rudder 10B have the common (the same) turning axis 5.

The upper steering machine 20A and the lower steering machine 20B have functions for independently turning the upper rudder 10A and the lower rudder 10B, respectively.

That is, the upper rudder 10A and the lower rudder 10B can turn to each of a port side 7 and a starboard side

6 from the axis of the propeller 8. Preferably, the maximum value of a turning angle of each of the upper rudder 10A and the lower rudder 10B is 90° or more to the port side 7 and the starboard side 6 with respect to the propeller center 4.

[0030]

According to the above-described configuration, the upper rudder 10A and the lower rudder 10B are disposed (behind and on the axis of the propeller 8) at the propeller center 4, and thus, it is possible to more effectively recover energy of propeller vortex flows 9a and 9b by the upper rudder 10A and the lower rudder 10B.

[0031]

Particularly, when a ship goes straight ahead or turns, in the rudder 100 for ships of the present invention, the upper rudder 10A and the lower rudder 10B are independently turned to obtain appropriate steering angles, and thus, it is possible to always realize a steering angle suitable for recovery of the energy of the propeller vortex flows 9a and 9b at any rotational speed of the propeller. As a result, compared to one rudder in which the upper rudder 10A and the lower rudder 10B are integrated with each other, in the rudder 100 for ships of the present invention, it is possible to generate high lift and decrease a total rudder area.

[0032]

In addition, compared to the one rudder in which the

upper rudder 10A and the lower rudder 10B are integrated with each other, a rudder area of the upper rudder 10A and the lower rudder 10B is approximately halved. Accordingly, a blade thickness decreases, and it is possible to improve
5 rudder single body performance.

[0033]

In Figs. 1 and 2, the upper steering machine 20A includes an upper steering shaft 22a and an upper steering gear 24a. The upper steering shaft 22a is a hollow
10 cylindrical shaft, a lower end thereof is fixed to the upper rudder 10A, and the upper steering shaft 22a extends upward along the turning axis 5. The upper steering gear 24a turns an upper end portion of the upper steering shaft 22a about the turning axis 5. Preferably, the maximum
15 value of this turning angle is 90° or more to the port side 7 and the starboard side 6.

[0034]

In addition, the lower steering machine 20B includes a lower steering shaft 22b and a lower steering gear 24b.
20 In this example, the lower steering shaft 22b is a solid shaft, a lower end thereof is fixed to the lower rudder 10B, and the lower steering shaft 22b extends upward along the turning axis 5. The lower steering gear 24b turns an upper end portion of the lower steering shaft 22b about the
25 turning axis 5. Preferably, the maximum value of this turning angle is 90° or more to the port side 7 and the starboard side 6.

[0035]

According to the above-described configuration,
compared to one rudder in which the upper rudder 10A and
the lower rudder 10B are integrated with each other, the
5 rudder area of the upper rudder 10A and the lower rudder
10B is approximately halved, and a design load of the upper
rudder 10A and the lower rudder 10B decreases. Accordingly,
the required maximum torque of each of the upper steering
shaft 22a and the lower steering shaft 22b is approximately
10 halved, and each necessary dimension (for example,
diameter) can be reduced (narrowed).

[0036]

Preferably, the turning axis 5 is positioned around
the center of the cord length L of each of the upper rudder
10A and the lower rudder 10B or around the maximum
15 thickness portion thereof. Moreover, a thickness of the
lower rudder 10B is required to be larger than a diameter
of the lower steering shaft 22b at a connection portion
between the lower rudder 10B and the lower steering shaft
20 22b.

[0037]

As described above, compared to the one rudder in
which the upper rudder 10A and the lower rudder 10B are
integrated with each other, the rudder area is
25 approximately halved, and the design load decreases.
Accordingly, it is possible to decrease (narrow) the
diameter of the lower steering shaft 22b compared to the

conventional art, and a thickness distribution of the lower rudder 10B can be made thinner than that of the conventional art. Moreover, in this case, it is possible to independently turn the lower rudder 10B at a steering
5 angle suitable for recovery of the energy of the propeller vortex flow 9b, and thus, it is possible to increase an energy recover rate of the propeller vortex flow 9b.

[0038]

Meanwhile, it is necessary to provide a through-hole
10 11 (described later) in the upper rudder 10A, and thus, a thickness of the upper rudder 10A is larger than a thickness of the lower rudder 10B. However, compared to one rudder in which the upper rudder 10A and the lower rudder 10B are integrated with each other, the rudder area
15 is approximately halved and the design load decreases. Accordingly, it is possible to decrease (thin) the diameter of the upper steering shaft 22a compared to the conventional art. Moreover, in this case, it is possible to independently turn the upper rudder 10A at a steering
20 angle suitable for recovery of the energy of the propeller vortex flow 9a, and thus, it is possible to increase an energy recover rate of the propeller vortex flow 9a.

[0039]

In Figs. 1 and 2, the hollow cylindrical upper
25 steering shaft 22a and the solid lower steering shaft 22b are a double tube coaxial with the turning axis 5.

[0040]

The upper steering shaft 22a is attached to the inside of the housing 26 provided on the stern 2 so as to be rotatable about the turning axis 5 via first bearings 27a. Moreover, a gap between the upper steering shaft 22a and the housing 26 is sealed by a seal (not illustrated) such that seawater W does not flow in from the gap.

The upper rudder 10A includes the through-hole 11 which penetrates from an upper surface of the upper rudder 10A to a lower surface thereof along the turning axis 5.

10 [0041]

The lower steering shaft 22b is attached to the insides of the through-hole 11 and the upper steering shaft 22a so as to be rotatable about the turning axis 5 via a second bearing 27b. In addition, gaps between the upper steering shaft 22a and the through-hole 11 and between the upper steering shaft 22a and the lower steering shaft 22b, are sealed by seals (not illustrated) such that the seawater W does not flow in from the gap.

[0042]

20 The upper steering gear 24a includes an upper chiller 28a which is fixed to an upper end of the upper steering shaft 22a and extends horizontally, and a plurality of hydraulic cylinders 29a which horizontally oscillates the upper chiller 28a about the turning axis 5.

25 The lower steering gear 24b includes a lower chiller 28b which is fixed to an upper end of the lower steering shaft 22b and extends horizontally, and a plurality of

hydraulic cylinders 29b which horizontally oscillates the lower chiller 28b about the turning axis 5.

The hydraulic cylinders 29a and 29b are independently controlled by hydraulic units (not illustrated) so as to independently turn the upper rudder 10A and the lower rudder 10B, respectively.

[0043]

As described above, compared to the one rudder in which the upper rudder 10A and the lower rudder 10B are integrated with each other, the rudder area of the upper rudder 10A and the lower rudder 10B is approximately halved, and the design load of the upper rudder 10A and the lower rudder 10B decreases, and thus, the required maximum torque of each of the upper steering gear 24a and the lower steering gear 24b is approximately halved. Therefore, it is possible to decrease sizes of components configuring the upper steering gear 24a and the lower steering gear 24b.

[0044]

Fig. 3A is a schematic plan view of Fig. 1. In this drawing, the upper rudder 10A is indicated by a solid line and the lower rudder 10B is indicated by a broken line.

[0045]

In this drawing, the thickness distribution of the lower rudder 10B is thinner than that of the upper rudder 10A.

In addition, in a case where a rotation direction of the propeller is the clockwise direction when viewed from

the rear side, the upper rudder 10A has an airfoil shape suitable for the propeller vortex flow 9a (indicated by an arrow of a solid line) flowing from the port side 7 to the starboard side 6.

5 Moreover, in a case where the rotation direction of the propeller is the clockwise direction when viewed from the rear side, the lower rudder 10B has an airfoil shape suitable for the propeller vortex flow 9b (indicated by an arrow of a broken line) flowing from the starboard side 6
10 to the port side 7.

[0046]

Fig. 3B is an explanatory view of a fluid force generated in the upper rudder 10A when a ship goes straight ahead.

15 The vortex flow 9a flowing from the port side 7 to the starboard side 6 with respect to the upper rudder 10A generates a lift L_a in a direction perpendicular to the flow and a drag D_a in a direction parallel to the flow. By selecting the steering angle and the airfoil shape of the
20 upper rudder 10A so that a component force in a forward direction of lift L_a is larger than that of drag D_a , it is possible to efficiently obtain the component force in the forward direction.

[0047]

25 Fig. 3C is an explanatory view of a fluid force generated in the lower rudder 10B when a ship goes straight ahead.

The vortex flow 9b flowing from the starboard side 6 to the port side 7 with respect to the lower rudder 10B generates a lift L_b in a direction perpendicular to the flow and a drag D_b in a direction parallel to the flow. By selecting the steering angle and the airfoil shape of the lower rudder 10A so that a component force in a forward direction of lift L_b is larger than that of drag D_b , it is possible to efficiently obtain the component force in the forward direction.

[0048]

That is, in this example, the upper rudder 10A and the lower rudder 10B have the airfoil shapes or camber lines of the airfoil shapes different from each other.

[0049]

According to the above-described configuration, compared to the one rudder in which the upper rudder 10A and the lower rudder 10B are integrated with each other when a ship goes straight ahead, in the rudder 100 for ships of the present invention, the energy of the propeller vortex flows 9a and 9b is effectively recovered, and it is possible to effectively obtain the component force in the forward direction of the fluid force generated in the rudder.

Moreover, the upper rudder 10A and the lower rudder 10B are not limited to this example. That is, as long as the upper rudder 10A and the lower rudder 10B have the airfoil shapes suitable for the propeller vortex flows 9a

and 9b, they may have fins F (indicated by broken lines in Fig. 3A) or a flap (not illustrated) to obtain high lift.

[0050]

In addition, the upper rudder 10A and the lower
5 rudder 10B of the present invention are not limited to the above-described configuration. That is, the airfoil shape of each of the upper rudder 10A and the lower rudder 10B may have any shape as long as the starboard side 6 and the port side 7 thereof is symmetrical to the propeller center
10 4.

[0051]

The ship 1 of the present invention has the above-described rudder 100 for ships.

The ship 1 has the above-described rudder 100 for
15 ships, and thus, it is possible to shorten the cord length L of the rudder, disposition of the stern is facilitated, and it is possible to reduce enlargement of the stern.

In addition, the ship 1 of the present invention is not limited to the propeller 8 having one axis and may be
20 the propeller 8 having two or three or more axes. In this case, preferably, the upper rudder 10A, the lower rudder 10B, the upper steering machine 20A, and the lower steering machine 20B described above are provided each axis of the plurality of propellers 8. Moreover, in the ship 1 of the
25 present invention, the upper rudder 10A, the lower rudder 10B, the upper steering machine 20A, and the lower steering machine 20B described above may be provided in only some

propellers 8 among the plurality of propellers 8.

[0052]

A steering method of the rudder 100 for ships of the present invention includes preparing the upper rudder 10A,
5 the lower rudder 10B, the upper steering machine 20A, and the lower steering machine 20B described above and independently turning the upper rudder 10A and the lower rudder 10B.

[0053]

10 Figs. 4A, 4B, and 4C are explanatory views of the steering method of the present invention.

Hereinafter, a case in which the starboard side 6 and the port side 7 are symmetrical in each of the upper rudder 10A and the lower rudder 10B and the thickness
15 distribution of the lower rudder 10B is thinner than that of the upper rudder 10A will be described. In addition, in the following descriptions, the fluid force applied to the rudder is divided into a forward-rearward direction component F and a right-left direction component S. In the
20 fluid force applied to the upper rudder 10A, the forward-rearward direction component is defined as F_a and the right-left direction component is defined as S_a , and in the fluid force applied to the lower rudder 10B, the forward-rearward direction component is defined as F_b and the
25 right-left direction component is defined as S_b .

[0054]

Fig. 4A is a view illustrating positions of the

upper rudder 10A and the lower rudder 10B when a ship goes straight ahead and Fig. 4B is a view illustrating positions of the upper rudder 10A and the lower rudder 10B when the ship turns left.

5 [0055]

As illustrated in Fig. 4A, the positions of the upper rudder 10A and the lower rudder 10B when the ship goes straight ahead substantially coincide with each other in a plan view, and similarly to the one rudder in which
10 the upper rudder 10A and the lower rudder 10B are integrated with each other, it is possible to effectively recover the energy of the propeller vortex flows 9a and 9b.

[0056]

Moreover, as illustrated in Fig. 4B, the positions
15 of the upper rudder 10A and the lower rudder 10B when the ship turns left can substantially coincide with each other in a plan view, and thus, this is similar to the case of the one rudder in which the upper rudder 10A and the lower rudder 10B are integrated with each other. However, the
20 lower rudder 10B has a small contribution to the left turning while the upper rudder 10A provides a force which contributes to the left turning. Accordingly, it is not possible to effectively use the energy of the propeller vortex flows 9a and 9b. There are similar problems when
25 the ship turns right.

[0057]

Fig. 4C is another view illustrating positions of

the upper rudder 10A and the lower rudder 10B when the ship turns left.

As described above, the propeller vortex flow 9a flowing from the port side 7 to the starboard side 6 is applied to the upper rudder 10A, and the propeller vortex flow 9b flowing from the starboard side 6 to the port side 7 is applied to the lower rudder 10B.

Accordingly, as illustrated in this drawing, in the steering method of the present invention, even when the ship turns left, the upper rudder 10A and the lower rudder 10B are independently turned to obtain appropriate steering angles, and thus, it is possible to exert high lift effectively using the energy of the propeller vortex flows 9a and 9b according to the rotation speed of the propeller. This is similar when the ship turns right and goes straight ahead.

[0058]

Figs. 5A and 5B are explanatory views of the steering method of the present invention during deceleration.

As illustrated in the drawings, in the steering method of the present invention, during the deceleration, one of the upper rudder 10A and the lower rudder 10B turns to the port side 7, and the other thereof turns to the starboard side 6.

[0059]

Fig. 5A is a view illustrating a deceleration mode

of 90°, that is, a view illustrating a state where the upper rudder 10A turns to the port side 7 by approximately 90° and the lower rudder 10B turns to the starboard side 6 by approximately 90°. In this case, the rudder is disposed
5 nearly a right angle with respect to the flow, and thus, lift cannot be obtained, and remarkable drag is generated. As a result, a large fluid force is generated in the rudder in a direction opposite to the forward direction, and thus, the ship 1 can be rapidly decelerated.

10 [0060]

Fig. 5B is a view illustrating a deceleration mode of 30°, that is, a view illustrating a state where the upper rudder 10A turns to the port side 7 by approximately 30° and the lower rudder 10B turns to the starboard side 6
15 by approximately 30°.

Compared to the steering angle (Fig. 5A) of 90°, in the steering angle of 90° or less, for example, in the case of the deceleration mode of 30° of Fig. 5B, deceleration effects decreases, but similar effects are obtained.

20 [0061]

The maximum steering angle of each of the upper rudder 10A and the lower rudder 10B may be 90° or more to the starboard side 6 and the port side 7.

According to this configuration, even when the ship
25 1 moves backward, it is possible to obtain steering performance of the ship 1.

[0062]

Figs. 6A and 6B are explanatory views of the steering method of the present invention during deceleration turning.

[0063]

5 Fig. 6A is a view illustrating a deceleration right turning mode, that is, a view illustrating a state where the upper rudder 10A turns to the port side 7 by approximately 90° and the lower rudder 10B turns to the starboard side 6 by approximately 30°. In this case, the
10 upper rudder 10A mainly plays a role of decelerating and the lower rudder 10B mainly plays a role of turning right, and thus, the ship 1 can turn right while decelerating.

[0064]

15 Fig. 6B is a view illustrating a deceleration left turning mode, that is, a view illustrating a state where the upper rudder 10A turns to the port side 7 by approximately 30° and the lower rudder 10B turns to the starboard side 6 by approximately 90°. In this case, the
20 upper rudder 10A mainly plays a role of turning left and the lower rudder 10B mainly plays a role of decelerating, and thus, the ship 1 can turn left while decelerating.

[0065]

25 Moreover, the above-described steering method of the present invention can be similarly applied to the case where the upper rudder 10A and the lower rudder 10B have the camber lines of the airfoil shapes and the airfoil shapes different from each other.

[0066]

According to the above-described invention, the upper rudder 10A and the lower rudder 10B are disposed at the propeller center 4 (behind or on the axis of the propeller 8), and thus, it is possible to effectively recover energy of the propeller vortex flows 9a and 9b by the upper rudder 10A and the lower rudder 10B.

[0067]

Particularly, when a ship goes straight ahead or turns, in the rudder 100 for ships of the present invention, the upper rudder 10A and the lower rudder 10B are independently turned to obtain appropriate steering angles, and thus, it is possible to always realize the steering angle suitable for recovery of energy of the propeller vortex flows 9a and 9b at any rotational speed of the propeller. As a result, compared to the one rudder in which the upper rudder 10A and the lower rudder 10B are integrated with each other, in the rudder 100 for ships of the present invention, it is possible to generate high lift and decrease a total rudder area.

[0068]

Moreover, compared to the one rudder in which the upper rudder 10A and the lower rudder 10B are integrated with each other, the rudder area of the upper rudder 10A and the lower rudder 10B is approximately halved, and thus, the design load of the upper rudder 10A and the lower rudder 10B decreases. Accordingly, the blade thickness

decreases, and it is possible to improve rudder single body performance.

[0069]

Therefore, according to the present invention, it is possible to effectively use the energy of the propeller vortex flows 9a and 9b and decrease the area and the blade thickness of the rudder.

[0070]

The present invention is not limited to the above-described embodiment, and it is needless to say that various modifications can be made within the scope which does not depart from the gist of the present invention.

Reference Signs List

15 [0071]

F: fin

H: rudder height

L: cord length

W: seawater

20 1: ship

2: stern

3: baseline

4: propeller center

5: turning axis

25 6: starboard side

7: port side

8: propeller

9a, 9b: propeller vortex flow
10A: upper rudder
10B: lower rudder
11: through-hole
5 20A: upper steering machine
20B: lower steering machine
22a: upper steering shaft
22b: lower steering shaft
24a: upper steering gear
10 24b: lower steering gear
26: housing
27a: first bearing
27b: second bearing
28a: upper chiller
15 28b: lower chiller
29a, 29b: hydraulic cylinder
100: rudder for ships

CLAIMS

1. A rudder for ships, comprising:

an upper rudder and a lower rudder which are
5 vertically disposed behind and on an axis of a propeller
disposed at a stern,

wherein the upper rudder and the lower rudder are
able to be independently turned to a port side and a
starboard side from the axis of the propeller.

10

2. The rudder for ships according to claim 1,
further comprising:

an upper steering machine and a lower steering
machine which are able to independently turn the upper
15 rudder and the lower rudder.

3. The rudder for ships according to claim 1 or 2,
wherein a thickness distribution of the lower rudder
is thinner than that of the upper rudder.

20

4. The rudder for ships according to claim 1 or 2,
wherein in a case where a rotation direction of the
propeller is the clockwise direction when viewed from a
rear side,

25 the upper rudder has an airfoil shape suitable for a
propeller vortex flow flowing from the port side to the
starboard side, and

the lower rudder has an airfoil shape suitable for a propeller vortex flow flowing from the starboard side to the port side.

5 5. The rudder for ships according to claim 1 or 2, wherein the upper rudder and the lower rudder have the airfoil shapes or camber lines of the airfoil shapes different from each other.

10 6. A steering method, comprising:
preparing an upper rudder and a lower rudder which are vertically disposed behind and on an axis of a propeller disposed at a stern; and
independently turning the upper rudder and the lower
15 rudder to a port side and a starboard side from the axis of the propeller.

7. The steering method according to claim 6, wherein during deceleration or deceleration turning,
20 one of the upper rudder and the lower rudder is turned to the port side, and the other thereof is turned to the starboard side.

8. A ship comprising the rudder for ships according
25 to any one of claims 1 to 5.